Space Weather Technical Forecast

Issued on Saturday, 30 October 2021 at 13:07 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: CME arrival expected day 1 (30th) with G1/G2 Minor to Moderate storms and isolated G3 Strong Storms day 1 and day 2. G3 Watch issued. Chance of M-class flares. S1 Proton Storm ongoing.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was low, with three C-class flares detected, the largest a C3 at 30/0315 UTC from AR2891 (Dac/Beta) in the northeast. This remains the largest sunspot region on the visible disc, and saw some splitting of its leading penumbra and a little magnetic simplification during the period. There are currently three further active region in view, with AR28887 (Dsi/Beta/Gamma) in the southeast seeing some consolidation of its trailing group, but maintaining a Beta-Gamma magnetic configuration. AR2886 (Hsx/Alpha) has now rotated away into the southwest limb, and a new and as yet un-numbered region in the northwest remains as a simple bi-polar spot at present. A prominence eruption was seen on the southwest limb around 29/1900 UTC, however, no Earth-directed CMEs were evident in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured by DSCOVR at L1 was at slow-ambient levels between 280 and 340 km/s, with average to above average density values of 5-22 ppcc. Total IMF Bt was weak at 2-8 nT, with an unremarkable north-south component Bz of +5 to -6 nT. Phi angle was in a predominantly negative (toward sun) direction. Resultant geomagnetic activity was Quiet (Kp0-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured by GOES-16 was at S1/ Minor Storm values throughout, between 13 and 21 pfu. The 100 MeV Protons were at active thresholds (above 1pfu) until 30/0440 UTC. The high energy electron flux (greater than 2 MeV) was predominantly at background levels with the associated 24-hour electron fluence below the Active (1e8 integrated pfu) threshold, with 1.77e6 integrated pfu recorded at 30/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity is forecast is forecast to be low over the next 4 days with a chance of further M-class flares and slight chance (5%) of another X-class flare, primarily from AR2891.

Solar Wind / Geomagnetic Activity: A large CME from an X-class flare eruption on the 28th is forecast to arrive at Earth during the second half of Day 1 (30th), most likely around 1600UTC. Geomagnetic activity is expected to be quiet to start, but during the CME transit, minor to moderate geomagnetic storms (G1/G2 Kp5-6) are expected, with a likelihood of isolated G3/Strong storms (Kp7). Geomagnetic activity is then expected to gradually subside during the latter part of Day 2 into Day 3 (31st and 1st) with an eventual return to Quiet to Unsettled, with a chance of Active intervals (Kp2-4). A further solar wind enhancement is possible late on day 4 (2nd) due to the arrival of the fast wind of CH16, with Active to G1/Minor Storm intervals possible.

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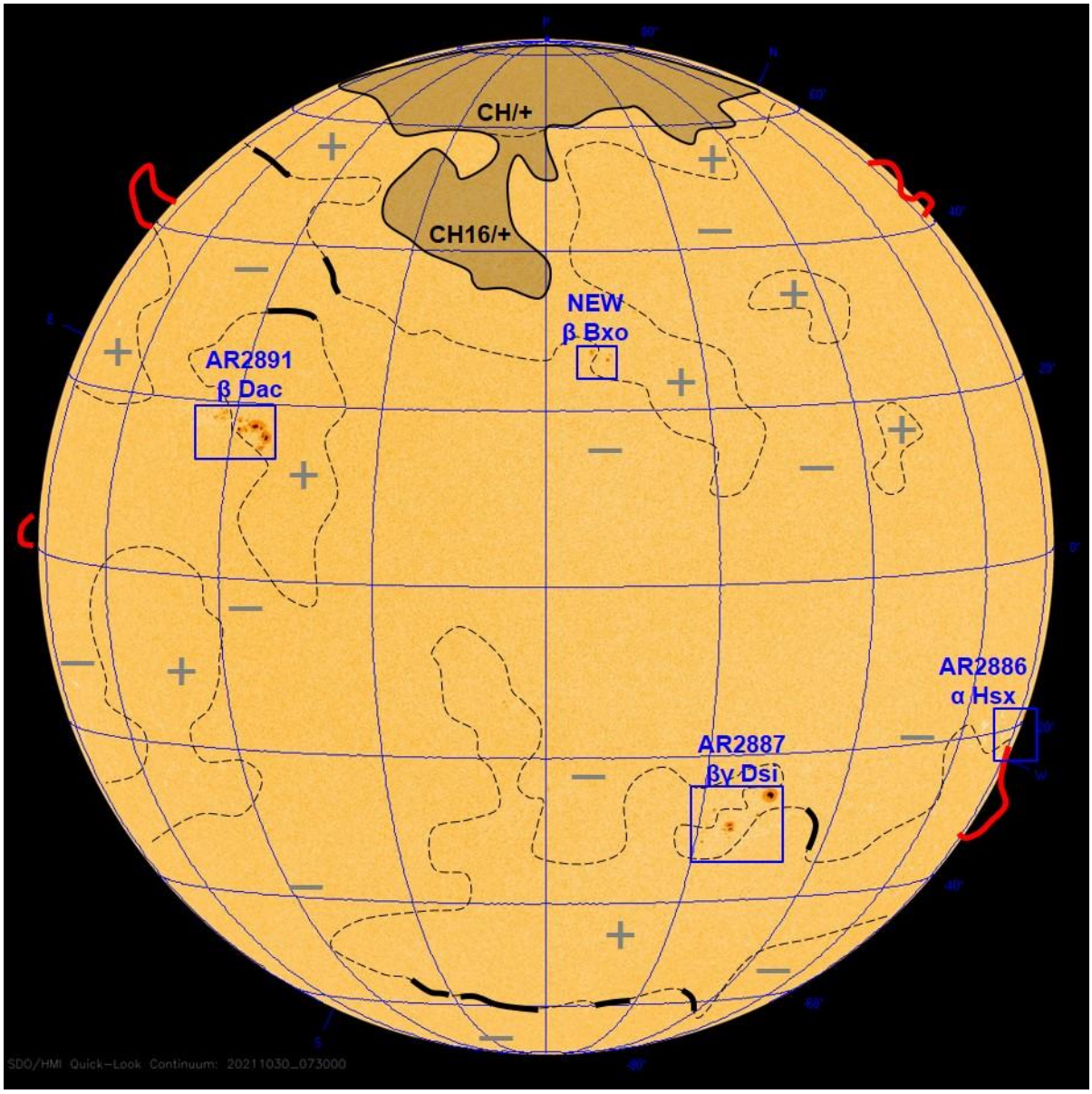
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be above S1 level at first, declining through day 1 (30th) and likely falling below the S1 level by early day 2 (31st). There is an ongoing 5% chance of further enhancement from any notable flares. The high energy electron flux (greater than 2 MeV) is forecast to remain mostly at background levels between days 1 and 2 (30th and 31st), but with a risk of exceeding the Active level (1e3pfu) threshold at times later day 2 and day 3 (31st into the 1st) as geomagnetic activity following the expected CME arrival subsides. From a low start, the associated 24 hour fluence is expected to remain largely below the Active (1e8 integrated pfu) level, but with a slight chance of exceeding this threshold on day 3 or 4 (1st November).

Figure 1. Solar Analysis Valid 30/0800 UTC



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A large full-halo CME was observed leaving the sun in coronagraph imagery following the X-class flare from AR2887 on the 28th at 1535UTC. This feature has been analysed, is Earth-directed, and currently expected to arrive 30/1200-2400 UTC, with most likely arrival time of 1600 UTC. A further small eruption that occurred on the 26/2000 UTC has the potential to give glancing effects on passing behind the Earth on day 1 (30th) or early day 2 (31st), but anything from this is likely to be swept up in the larger CME.

Solar winds are currently at background levels, and expected to become enhanced with the CME arrival, before easing day 3 (1st) onward. Later day 4 (2nd), a further enhancement is possible from the arrival of the fast wind of positive polarity coronal hole 16, which is a southern extension of the northern polar crown.

Geomagnetic activity is forecast to be mainly Quiet at first day 1 (30th), Minor to Moderate Geomagnetic storms (G1/G2) are then expected with the CME, with a likelihood of isolated G3/Strong storms (Kp7). Geomagnetic activity is then expected to gradually subside later day 2 and more especially day 3 (31st to 1st November) with an eventual return to Quiet to Unsettled levels, with a chance of Active intervals (Kp2-4). There is then a chance of G1/Minor storm intervals later day 4 from any fast wind arrival from CH16.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	90	80	40	30
Strong	G3	No	60	60	5	1
Severe	G4	No	10	10	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/1535	Full halo	X1 flare	AR2887	1200	30/1600 UTC	G1/G2 storms expected, G3 likely

Figure 2: Current Enlil forecast for CME arrival on 30th.

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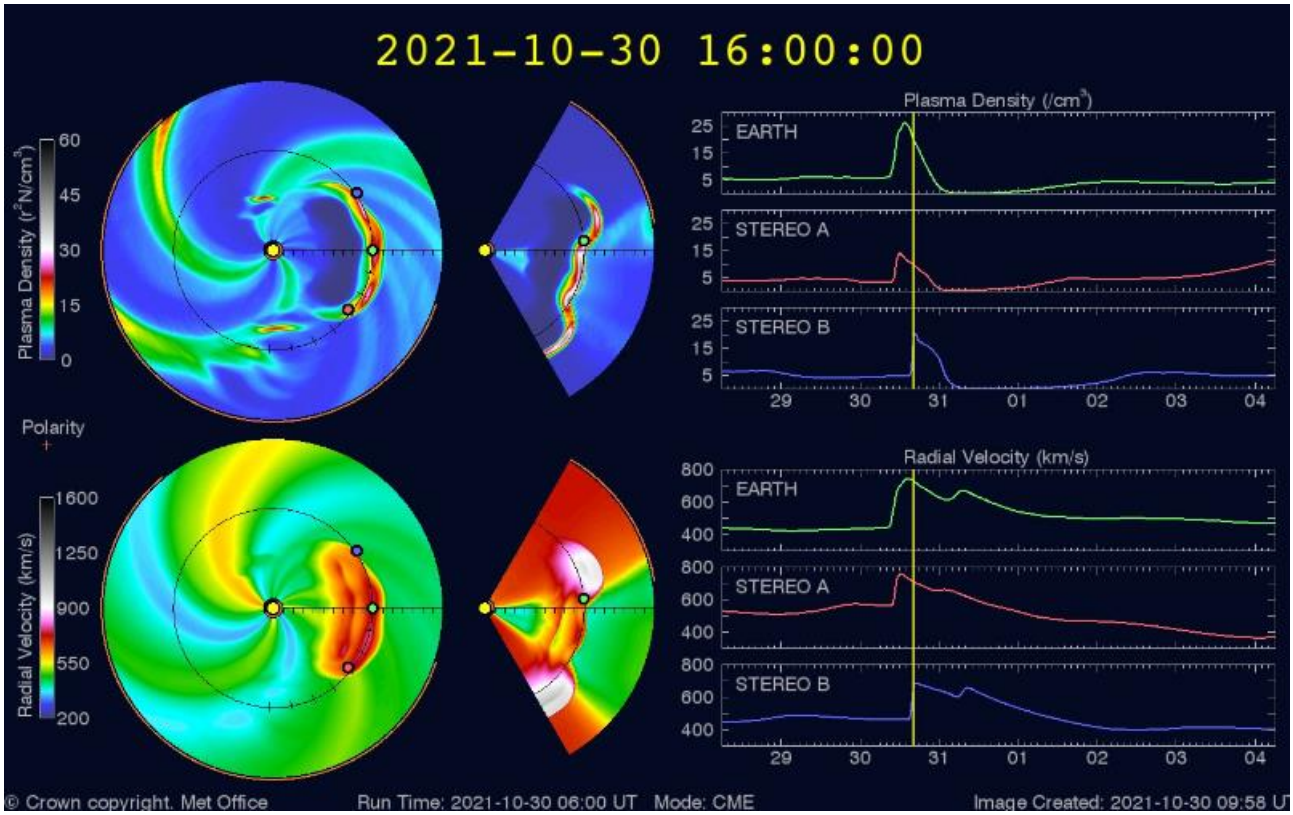

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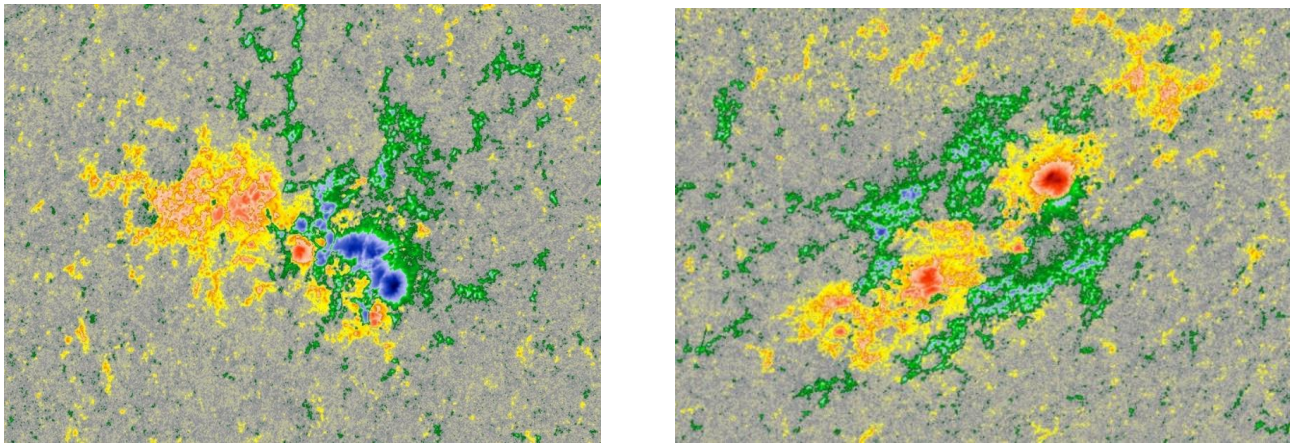
Radio Blackouts - X-Ray Flares:

Solar Activity is currently low, with three sunspots on the Earth-facing disc, and just three C-class flares in the last 24 hours. AR2891 Dkc/Beta-gamma in the northeast is currently the largest, and saw some splitting of its leading penumbra and a little magnetic simplification during the period. AR28887 (Dsi/Beta/Gamma) in the southeast has seen some consolidation of its trailing group, but maintains a Beta-Gamma magnetic configuration. AR2886 (Hsx/Alpha) has now rotated away into the southwest limb, and a new and as yet un-numbered region in the northwest remains as a simple bi-polar spot at present. SDO/AIA 171 imagery shows some looping on the northeast limb, signalling the potential for a further sunspot region to rotate on the visible disc during day 1 (30th), although no significant activity has been evident in STEREO EUVI imagery.

Solar Activity is forecast to be low, with the chance of M-class flares, from either AR2891 or AR2887, but just a slight 5% chance of X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: SDO/AIA Magnetogram views of AR2891 (left) and AR2887 (right)



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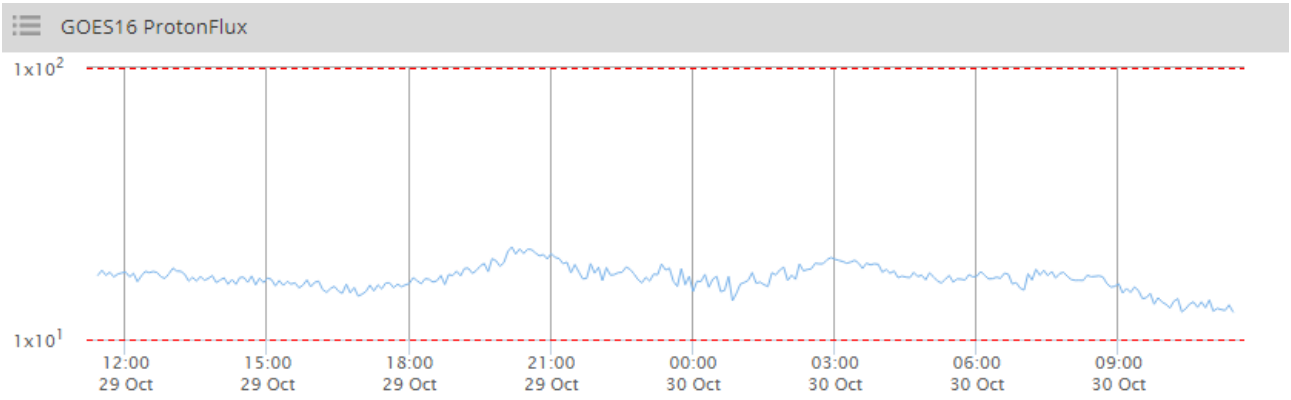
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is currently at S1/Minor storm levels. In the absence of any further significant flares the high energy proton flux is expected to gradually decline, but likely remaining above the S1 level until day 2 (31st), but with a chance of falling below on day 1 (30th). There is a 5% chance of a further enhancement from any notable flares that occur, with AR2887, which was the source of the X-flare and subsequent protons storm, having now simplified a little.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	100	60	10	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Past 24 hours proton flux, above the S1 Storm (10 pfu) level



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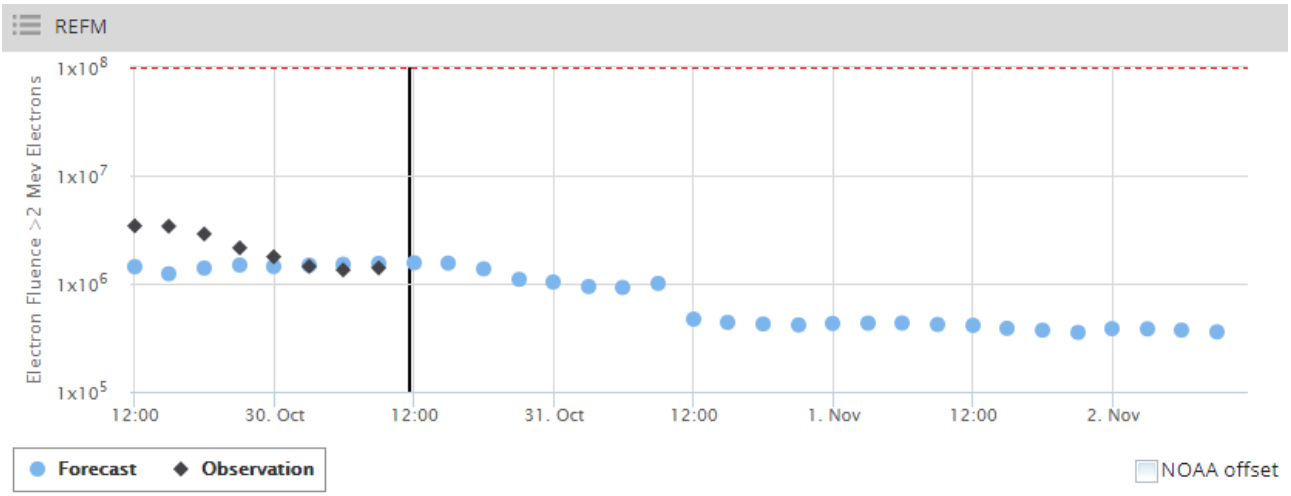
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) as observed by GOES-16 at GEO is currently at background levels and expected to persist at this or moderate levels for much of the period. The expected arrival of the CME on day 1 (30th) has the potential to inject electrons into the Van Allen radiation belts. As geomagnetic activity subsides a little day 2 (31st) onward, this would then likely be reflected at GEO, with electron flux potentially increasing to above the alert threshold (1000 pfu) although confidence is low. This giving a chance of reaching the Active fluence threshold (1e8 integrated pfu) day 3 onward (1st). REFM is expected to give reasonably good guidance at first, but doesn't take account of the expected CME arrival on the 30th.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	20	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: Latest MOSWOC REFM data. Subsiding geomagnetic activity by 1st Nov is expected to allow electron counts and fluence values to rise, this not captured by the model.



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